**CAP 5100 Human-Computer Interaction** 3 Credits  
**Grading Scheme:** Letter Grade  
Topics related to interaction with technology, including interface design, software tools, 3-D interaction, virtual environments, interaction devices, collaboration, and visualization.  
**Prerequisite:** COP 3530, and any one programming course (COP 2800, COP 3275, or COP 3229).

**CAP 5108 Research Methods for Human-Centered Computing** 3 Credits  
**Grading Scheme:** Letter Grade  
Introduces the fundamental methods and techniques to evaluate technologies and collect data from humans, including experimental design, types of variables, types of errors, hypothesis testing, survey design, behavioral and psychophysical methods.  
**Prerequisite:** STA 3032, COT 3100, COP 3530, or equivalent.

**CAP 5416 Computer Vision** 3 Credits  
**Grading Scheme:** Letter Grade  
Introduction to image formation and analysis. Monocular imaging system projections, camera model calibration, and binocular imaging. Low-level vision techniques, segmentation and representation techniques, and high-level vision.  
**Prerequisite:** Prerequisites MAC 2312 or equivalent, COT 4501 or equivalent and Proficiency in MATLAB or C++ or Java. Course instructor will determine equivalency.

**CAP 5510 Bioinformatics** 3 Credits  
**Grading Scheme:** Letter Grade  
Basic concepts of molecular biology and computer science. Sequence comparison and assembly, physical mapping of DNA, phylogenetic trees, genome rearrangements, gene identification, biomolecular cryptology, and molecular structure prediction.  
**Prerequisite:** CIS 3020 or equivalent.

**CAP 5515 Computational Molecular Biology** 3 Credits  
**Grading Scheme:** Letter Grade  
Algorithms related to molecular biology. Sequence comparisons, pattern matching, pattern extraction, graph techniques in phylogeny construction, secondary structure prediction, multiple sequence alignment, contig search, DNA computing, computational learning theory, and genetic algorithms.  
**Prerequisite:** COP 3530.

**CAP 5635 Artificial Intelligence Concepts** 3 Credits  
**Grading Scheme:** Letter Grade  
Heuristic search, game theory, knowledge representation, logic, machine learning, AI languages and tools. Applications such as planning, natural language understanding, expert systems, and computer vision.  
**Prerequisite:** COP 3530.

**CAP 5705 Computer Graphics** 3 Credits  
**Grading Scheme:** Letter Grade  
Display device characteristics; system considerations, display algorithms. Curve and surface generation. Lighting models and image rendering.  
**Prerequisite:** COP 3530.

**CAP 5771 Introduction to Data Science** 3 Credits  
**Grading Scheme:** Letter Grade  
Introducing the basics of data science including programming for data analytics, file management, relational databases, classification, clustering and regression. The foundation is laid for big data applications ranging from social networks to medical and business informatics.  
**Prerequisite:** COP 3530 Data Structures and Algorithms or equivalent.

**CAP 6137 Malware Reverse Engineering** 3 Credits  
**Grading Scheme:** Letter Grade  
Introducing the theory and practice of software reverse engineering applied to analysis of malicious software (malware). Students learn techniques of static and dynamic analysis to help identify the behavior of programs presented without documentation or source code and to identify possible remediation and avoidance techniques.  
**Prerequisite:** CDA 3101;  
**Corequisite:** COP 5615 or consent of instructor.

**CAP 6516 Medical Image Analysis** 3 Credits  
**Grading Scheme:** Letter Grade  
Image formation, reconstruction mathematics (Fourier slice theorem, Abel, Hankel and Radon transforms), PDE-based denoising and segmentation, multidimensional clustering algorithms, iso-surface extraction, basic differential geometry of curves and surfaces, multidimensional splines, active 2D/3D models, image matching/registration with application to multimodal co-registration.  
**Prerequisite:** expertise in image proc./comp. vision, proficiency in C language or MATLAB.

**CAP 6610 Machine Learning** 3 Credits  
**Grading Scheme:** Letter Grade  
Concepts in developing computer programs that learn and improve with experience. Emphasis on methods based on probability, statistics, and optimization.  
**Prerequisite:** Mathematics for Intelligent Systems.

**CAP 6615 Neural Networks for Computing** 3 Credits  
**Grading Scheme:** Letter Grade  
Neural network models and algorithms. Adaptive behavior, associative learning, competitive dynamics and biological mechanisms. Applications include computer vision, cognitive information processing, control, and signal analysis.  
**Prerequisite:** CAP 5635.

**CAP 6617 Advanced Machine Learning** 3 Credits  
**Grading Scheme:** Letter Grade  
Advanced concepts in developing computer programs that learn and improve with experience. Emphasis on methods based on probability, statistics, and optimization.  
**Prerequisite:** CAP 6610.

**CAP 6685 Expert Systems** 3 Credits  
**Grading Scheme:** Letter Grade  
Production systems, meta-knowledge, heuristic discovery, in-depth examination of several expert systems including TEIRESIAS, AM, DENDRAL, MYCIN, IRIS, CASNET, INTERNIST, BACON, PROSPECTOR.  
**Prerequisite:** CAP 5635.

**CAP 6701 Advanced Computer Graphics** 3 Credits  
**Grading Scheme:** Letter Grade  
Curved surface representations, representation and visualization of higher-dimensional fields, advanced rendering, collision detection and collision response, and scene navigation in context of high-level graphics environments.  
**Prerequisite:** CAP 4730 or CAP 5705 or consent of instructor.
CAP 6769 Advanced Topics in Data Science 3 Credits
Grading Scheme: Letter Grade
Advanced topics in data science such as relational databases and parallel and distributed processing in the cloud, tree-based classifiers and support vector machines, dimensionality reduction and theories of visualization.
Prerequisite: Graduate standing, CAP 5771

CEN 6070 Software Testing and Verification 3 Credits
Grading Scheme: Letter Grade
Concepts, principles, and methods for software testing and verification. Topics include human and machine-based testing strategies, formal proofs of correctness, and software reliability.
Prerequisite: CEN 5035.

CEN 6075 Software Specification 3 Credits
Grading Scheme: Letter Grade
Concepts, principles, and methods for practical specification. System modeling, requirements exploration, validation and prototyping, and documentation techniques.
Prerequisite: CEN 5035.

CIS 5370 Computer and Information Security 3 Credits
Grading Scheme: Letter Grade
Covers systematic threat and risk assessment; programmed threats and controls in hardware, software, and human procedures; security policies, models, and mechanisms; theoretical limitations and practical implementations; certification and accreditation standards; and case study reviews. Coursework includes a significant term project.
Prerequisite: COP 4600 Operating Systems or equivalent

CIS 5731 Introduction to Cryptology 3 Credits
Grading Scheme: Letter Grade
Introducing classical and modern cryptography and cryptanalysis, including symmetric and asymmetric (public key) ciphers. It covers cryptographic hash functions, block and stream ciphers, as well as differential and linear cryptanalysis. It reviews BAN logic, applications of cryptography, cryptographic standards and protocols, and analyzes case studies of failed implementations.
Prerequisite: COT 3100 Applications of Discrete Structures or equivalent; Corequisite: COT 5405 Analysis of Algorithms or equivalent

CIS 6905 Individual Study 1-3 Credits, Max 6 Credits
Grading Scheme: Letter Grade
Individual Study
Prerequisite: consent of faculty member supervising the study.

CIS 6910 Supervised Research 1-5 Credits, Max 5 Credits
Grading Scheme: S/U
Supervised Research
Prerequisite: graduate status in CIS.

CIS 6930 Special Topics in CIS 3 Credits, Max 9 Credits
Grading Scheme: Letter Grade
Special Topics in CIS
Prerequisite: vary depending on topics.

CIS 6935 Graduate Seminar 1-12 Credits, Max 12 Credits
Grading Scheme: S/U
Presentations by visiting researchers, faculty members, and graduate students.

CIS 6940 Supervised Teaching 3 Credits, Max 5 Credits
Grading Scheme: S/U
A supervised teaching experience.

CIS 6971 Research for Master’s Thesis 1-15 Credits
Grading Scheme: S/U
Research for Master’s Thesis

CIS 7979 Advanced Research 1-12 Credits
Grading Scheme: S/U
Research for doctoral students before admission to candidacy. Designed for students with a master’s degree in the field of study or for students who have been accepted for a doctoral program. Not appropriate for students who have been admitted to candidacy.

CIS 7980 Research for Doctoral Dissertation 1-15 Credits
Grading Scheme: S/U
Research for Doctoral Dissertation
CNT 5106C Computer Networks 3 Credits
Grading Scheme: Letter Grade

CNT 5410 Computer and Network Security 3 Credits
Grading Scheme: Letter Grade
Issues, analysis, and solutions. Viruses, worms, logic bombs, network attacks, covert channels, steganography, cryptography, authentication, digital signatures, electronic commerce.
Prerequisite: COP 3530, COT 5405 ;
Corequisite: COP 4600.

CNT 5412 Network and System Security 3 Credits
Grading Scheme: Letter Grade
Examining networked threats and vulnerabilities; trust, identification, authentication, and authorization in networked and distributed systems; secure network protocols and standards; certification of network products; firewall configurations, intrusion detection, and anomaly detection; security flaws in network protocols and distributed applications. Coursework includes a significant term project.
Prerequisite: CNT 5106C: Computer Networks or equivalent; COP 4600 - Operating Systems or equivalent ;
Corequisite: COT 5405: Analysis of Algorithms or equivalent.

CNT 5517 Mobile Computing 3 Credits
Grading Scheme: Letter Grade
Emerging topics of wireless and mobile computing and networking including mobile computing models, mobile-IP, adhoc networks, Bluetooth, and 802.11b. Mobile database access and mobile transactions in context of emerging field of M-commerce.
Prerequisite: CNT 4007C.

CNT 6107 Advanced Computer Networks 3 Credits
Grading Scheme: Letter Grade
Computer network architecture, including topologies, media, switching, routing, congestion control, protocols, and case studies.
Prerequisite: COP 5615 , COP 5536 , and CNT 5106C

CNT 6885 Distributed Multimedia Systems 3 Credits
Grading Scheme: Letter Grade
Design issues; survey of recent advances, including compression, networking, and operating system issues.

COP 5536 Advanced Data Structures 3 Credits
Grading Scheme: Letter Grade
Development of efficient data structures used to obtain more efficient solutions to classical problems, such as those based on graph theoretical models, as well as problems that arise in application areas of contemporary interest.
Prerequisite: COP 3530.

COP 5556 Programming Language Principles 3 Credits
Grading Scheme: Letter Grade
History of programming languages, formal models for specifying languages, design goals, run-time structures, and implementation techniques, along with survey of principal programming language paradigms.
Prerequisite: COP 3530.

COP 5615 Distributed Operating System Principles 3 Credits
GradingScheme: Letter Grade
Concepts and techniques for efficient management of computer system resources.
Prerequisite: COP 4600.

COP 5618 Concurrent Programming 3 Credits
Grading Scheme: Letter Grade
Overview of principles and programming techniques. Reasoning about concurrency, synchronization, program structuring, multi-threaded server applications.
Prerequisite: COP 3100, 3530.

COP 5625 Programming Language Translators 3 Credits
Grading Scheme: Letter Grade
Anatomy of translators for high-level programming languages.
Prerequisite: COP 5566.

COP 5725 Database Management Systems 3 Credits
Grading Scheme: Letter Grade
Introduction to systems and procedures for managing large computerized databases.
Prerequisite: COP 3530, 4600, or equivalent.

COP 6726 Database System Implementation 3 Credits
Grading Scheme: Letter Grade
DBMS architecture, query processing and optimization, transaction processing, index structures, parallel query processing, object-oriented and object-relational databases, and related topics.
Prerequisite: COP 4600 and 4720 or COP 5725.

COT 5405 Analysis of Algorithms 3 Credits
Grading Scheme: Letter Grade
Introduction and illustration of basic techniques for designing efficient algorithms and analyzing algorithm complexity.
Prerequisite: COP 3530.

COT 5442 Approximation Algorithms 3 Credits
Grading Scheme: Letter Grade
Fundamentals of algorithmic paradigms, analysis, techniques, and software. Topics include greedy methods, randomized algorithms, IP-rounding, approximability, covering, packing, clustering, and network problems.
Prerequisite: COP 3530 or COT 5405

COT 5519 Sparse Matrix Algorithms 3 Credits
Grading Scheme: Letter Grade
Many applications in computational science rely on algorithms for large-scale sparse matrices (circuit simulation, finite-element methods, 'big data', Google StreetView, etc). Course equips students to understand and design methods that exploit sparsity in matrix computations. Focus is direct methods, which rely on combinatorics, graph theory and algorithms, and numerical methods.
Prerequisite: COT 3100, COT 4501, COT 3530

COT 5520 Computational Geometry 3 Credits
Grading Scheme: Letter Grade
Design, analysis, and implementation of algorithms and data structures to solve geometric problems. Applications in graphics, robotics, computational biology, data mining, and scientific computing. Convex hulls, Voronoi diagrams, triangulations, arrangements, and range searching.
Prerequisite: COP 3530.

COT 5515 Mathematics for Intelligent Systems 3 Credits
Grading Scheme: Letter Grade
Mathematical methods commonly used to develop algorithms for computer systems that exhibit intelligent behavior.
Prerequisite: MAC 2313, Multivariate Calculus; MAS 3114 or MAS 4105, Linear Algebra; STA 4321, Mathematical Statistics.
COT 6315 Formal Languages and Computation Theory 3 Credits
Grading Scheme: Letter Grade
Introduction to theoretical computer science including formal languages, automata theory, Turing machines, and computability.
Prerequisite: COP 3530 and familiarity with discrete mathematics and data structures.

EGN 5949 Practicum/Internship/Cooperative Work Experience 1-6 Credits, Max 6 Credits
Grading Scheme: S/U
Practical cooperative engineering work under approved industrial and faculty supervision.
Prerequisite: graduate student.

EGN 6913 Engineering Graduate Research 0-3 Credits
Grading Scheme: S/U
Course will provide the student with supervised research in a laboratory setting.